

# Model systems for the study of the chemical behavior of Element 104:

## 1. Solvent extraction with tributyl phosphate

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In earlier experiments the extraction of element 104, rutherfordium, from hydrochloric acid into tributyl phosphate (TBP) was studied and compared to its lighter homologues, zirconium and hafnium, to determine the influence of relativistic effects on the chemical properties of transactinide elements [1, 2]. The results obtained in these experiments were partly contradictory.

To resolve the contradictions, the extraction behavior of Zr and Hf was studied in detail to find a suitable model system for on-line experiments with element 104. The extraction was studied using conventional solvent extraction as well as extraction chromatography.

500  $\mu\text{L}$  of tracer solution containing  $^{88}\text{Zr}$  and  $^{181}\text{Hf}$  in hydrochloric acid of appropriate concentration were mixed for 1 minute with 500  $\mu\text{L}$  of undiluted TBP. Afterwards the sample was centrifuged for 30 seconds and 200  $\mu\text{L}$  aliquots were taken from the organic and the aqueous phases. The activity in both aliquots was assayed using a Ge gamma-ray detector.

Fig. 1 shows the percentage of activity extracted into the organic phase as a function of hydrochloric acid concentration. No extraction is found until the acid concentration exceeds 5 M, when zirconium begins to extract into the organic phase. The extraction of hafnium begins above 6 M and is always less than that of zirconium. At acid concentrations above 10 M, the extraction yield for both elements is higher than 90 percent. These results agree well with the extraction behavior published in the literature [2]. The low Hf extraction yield at high acid concentrations reported by Czerwinski et al. [1] could not be confirmed and is probably due to adsorption on teflon materials that were used in their experiments.

Fig. 2 shows the distribution coefficients for Zr and Hf. The  $K_D$  values were derived from the ratio of the specific activity in both phases.

### Footnotes and References

1. K. R. Czerwinski et al., *Radiochim. Acta* **64**, 29 (1994)
2. C. D. Kacher et al., *Radiochim. Acta* **75**, 127 (1996)

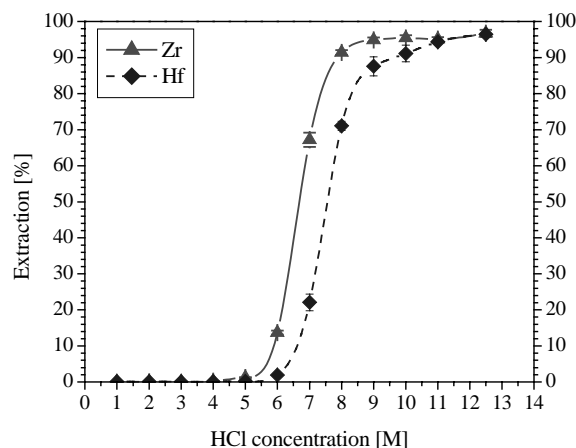


Fig. 1. Percent extraction of  $^{88}\text{Zr}$  and  $^{181}\text{Hf}$  from hydrochloric acid solutions into undiluted TBP

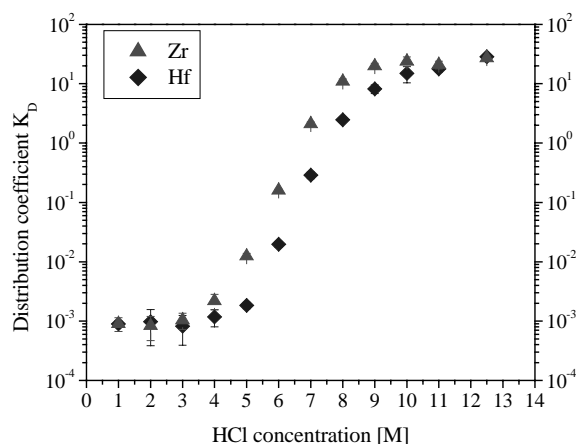


Fig. 2. Distribution coefficients for Zr and Hf in the system hydrochloric acid/undiluted TBP